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# *Brevet canadien / Canadian Patent*

Le commissaire aux brevets a reçu une demande de délivrance de brevet visant une invention. Ladite requête satisfait aux exigences de la *Loi sur les brevets*. Le titre et la description de l'invention figurent dans le mémoire descriptif, dont une copie fait partie intégrante du présent document.

Le présent brevet confère à son titulaire et à ses représentants légaux, pour une période expirant vingt ans à compter de la date du dépôt de la demande au Canada, le droit, la faculté et le privilège exclusif de fabriquer, construire, exploiter et vendre à d'autres, pour qu'ils l'exploitent, l'objet de l'invention, sauf jugement en l'espèce rendu par un tribunal compétent, et sous réserve du paiement des taxes périodiques.

The Commissioner of Patents has received a petition for the grant of a patent for an invention. The requirements of the *Patent Act* have been complied with. The title and a description of the invention are contained in the specification, a copy of which forms an integral part of this document.

The present patent grants to its owner and to the legal representatives of its owner, for a term which expires twenty years from the filing date of the application in Canada, the exclusive right, privilege and liberty of making, constructing and using the invention and selling it to others to be used, subject to adjudication before any court of competent jurisdiction, and subject to the payment of maintenance fees.

## BREVET CANADIEN **2,017,474** CANADIAN PATENT

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|---|---|---|
| Date à laquelle le brevet a été accordé et délivré | **1999/06/01** | Date on which the patent was granted and issued |
| Date du dépôt de la demande | **1990/05/24** | Filing date of the application |
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Commissaire aux brevets / Commissioner of Patents

FA

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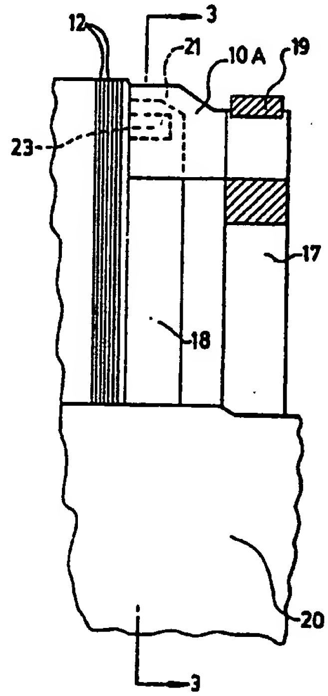
(54) **AMMORTISSEUR DE BAGUE DE COUVERTURE POUR MACHINE DYNAMO-ELECTRIQUE**

(54) **END RING DAMPING STRUCTURE FOR DYNAMOELECTRIC MACHINES**




(57) A rotor in a dynamoelectric machine of the squirrel cage type has a stack of laminations clamped at either end by a clamping ring and mounted to a rotor shaft. The stack of laminations has a plurality of axially extending peripheral openings with a rotor bar mounted in each opening and projecting from either end. An end ring at each end is electrically connected to the projecting ends of the rotor bars. The rotor bars and the end rings form a sub-assembly. The clamping ring at each end has fingers which extend radially between the projecting ends of adjacent rotor bars. The fingers adjacent and on either side of at least one rotor bar have damper block retaining pockets on the side thereof facing the one rotor bar. A damper block of resilient material is mounted in each pocket in engagement with the pocket and with the facing surface on the projecting end of the at least one rotor bar to reduce torsional vibration between the sub-assembly and the stack of laminations.

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# END RING DAMPING STRUCTURE FOR DYNAMOELECTRIC MACHINES

## Background of the Invention

This invention relates to a structure for damping vibration in a dynamoelectric machine, and in particular it relates to means for damping torsional vibration in the rotor of a squirrel cage type dynamoelectric machine.

A squirrel cage rotor for a dynamoelectric machine usually comprises a stack of steel laminations, clamped at the ends of the stack to form a rotor core. The core is mounted to a shaft for rotation within a stator. The laminations have a plurality of circumferentially spaced apart slots or openings extending axially therethrough. Rotor bars are mounted in the slots or openings, projecting outwardly at either end of the laminations. The stack of laminations is usually clamped by a clamping ring mounted to the shaft and extending outwardly to terminate just short of the projecting ends of the rotor bars. The clamping ring may have projecting fingers which extend between the projecting ends of the rotor bars to extend the clamping action outwardly. An end ring at each end of the stack of laminations is secured to the projecting ends of the rotor bars to make electrical connection therewith. A

retaining ring over the ends of the rotor bars and/or over the end rings, provides support for the assembly to prevent displacement of the ends of the rotor bars due to large currents in the rotor bars at large loads or during starting, or due to centrifugal forces.

If the laminations have axial peripheral slots to receive the rotor bars, the slots are frequently formed with inwardly extending projections to restrain the rotor bars against radial outward movement. Consequently the rotor bars are usually installed from an end by pressing them longitudinally into the slots. If the laminations have axially extending openings adjacent the periphery, the rotor bars are again installed from one of the ends. The openings or the slots usually have a clearance so that the rotor bars may be properly installed. This is important because the laminations are usually of steel whereas the rotor bars may be of aluminum. If there was no clearance between the sides of the rotor bar and the edges of the laminations which define the slot or opening, the edges of the steel laminations (which may not be perfectly flush) could peel away surface layers of the aluminum bar. Sometimes a rotor bar is made with a small protruding ridge along the bottom extending past the region provided for clearance so that the ridge may be peeled away or abraded during installation as necessary, but a tighter fit of the bar in the opening is provided.

It will be seen that the rotor bars and end rings form a fixed sub-assembly, that is, the rotor bars are fastened to the end rings by welding. The rotor bars extend through respective slots or openings (hereinafter both slots and openings will be referred to as openings) in the laminations and there is normally some clearance between at least parts of the surfaces of the rotor bars and at least parts of walls defining the

sl ts or penings in the core. This may permit torsional vibration between the core and the sub-assembly, particularly at resonant frequencies. This is of particular concern in variable speed machines where a resonant frequency is more likely to occur.

**Summary of the Invention**

The present invention provides damping to reduce torsional vibration in the rotor of a squirrel cage dynamoelectric machine. The torsional vibration is reduced by providing damper blocks wedged or mounted between at least one and preferably a plurality of rotor bars and adjacent fingers of the clamping ring. The fingers extend between adjacent rotor bars where the bars project beyond the end of the core, and the fingers preferably have a recess or pocket which receives the respective damper block to position and retain the block. The damper block engages the recess or pocket and the surface of the adjacent rotor bar to damp torsional vibration between the sub-assembly comprising the rotor bars and end rings and the rotor core.

It is therefore an object of the invention to provide damping means for reducing torsional vibration between the rotor bar sub-assembly and the rotor core of a squirrel cage dynamoelectric machine.

It is another object of the invention to provide, in a squirrel cage rotor of a dynamoelectric machine, a damping block between at least one rotor bar and the radially adjacent clamping ring structure.

Accordingly there is provided a damping means for damping torsional vibration in the rotor of a dynamoelectric machine having a rotor core comprising a stack of laminations, a plurality of circumferentially spaced openings extending axially through the core, a rotor bar in each opening projecting from either end of

the core, and an end ring at each end el ctrically connected to the projecting ends of the rotor bars at a respective end of the core, the rotor bars and the end rings forming a sub-assembly, comprising a clamping ring at each end of the core to clamp the stack of laminations together, the clamping rings having projecting fingers each extending between the projecting ends of adjacent rotor bars and spaced therefrom, at least one of the fingers having a damper block retaining pocket facing a projecting end of a rotor bar, and a damper block of resilient material mounted in the respective damper block retaining pocket engaging the pocket and a radially adjacent surface of the adjacent rotor bar to damp torsional vibration between the sub-assembly and the rotor core.

## Brief Description of the Drawings

The invention will be described with reference to the accompanying drawings, in which

Figure 1 is a sectional view of a rotor bar in an opening in a lamination in accordance with one form of prior art rotor bar structure,

Figure 2 is a partial sectional side view of the end of a rotor core according to one form of the invention,

Figure 3 is a sectional end view taken along line 3-3 of Figure 2, and

Figures 4A and 4B are partial sectional side views, similar to Figure 2, of the end of a rotor core and each showing another form of the invention.

## Detailed Description of the Preferred Embodiment

Referring first to Figure 1, a rotor bar 10 is shown in section within an opening 11 in a lamination 12 in a stack of laminations. The outward edge 14 of rotor

bar 10 is adjacent the periphery 15 of the circularly shaped lamination 12. In other prior art forms of rotor bar and laminations, the opening 11 may extend to the periphery 15. There are, of course, a plurality of openings 11 spaced circumferentially around the stack of laminations.

As is known, the rotor bars 10 are installed in a rotor core, which comprises a stack of laminations 12, by inserting each bar 10 endwise into a respective opening 11, and pressing the bar 10 until it extends through the core and projects from either end. To provide clearance for the insertion of the rotor bars, the opening 11 is slightly larger than the rotor bar 10 as shown. However, to make a reasonably snug fit, the rotor bar 10 may be arranged so that the edge 14 bears against the end of opening 11 and the rotor bar 10 may have a lip or protruding ridge 16 which bears against the opposite end of opening 11. The ridge 16 may be peeled away or abraded as the rotor bar 10 is pressed through a stack of laminations 12, however a tighter fit of each bar in its respective opening is provided. Nevertheless, vibration may occur perhaps because of the clearance provided.

Referring now to Figure 2, there is shown a partial side view of an end of a rotor core with a rotor bar 10A shown electrically connected, as by welding, to an end ring 17, and to Figure 3 where there is shown an end view taken along line 3-3 of Figure 2. The rotor bar 10A projects beyond the stack of laminations 12 (as do all the rotor bars 10) and each projecting end is welded or otherwise electrically connected to a respective end ring 17. Thus all the rotor bars are connected at each end of the stack of laminations to a respective end ring. A retaining ring 19 encircles each end ring 17 and the protruding ends of the rotor bars 10

t retain the bars and end rings against forces which are mainly centrifugal forces. A rotor clamping ring 18 at each end of the stack of laminations 12 is secured to rotor shaft 20 and clamps or retains the laminations 12 against axial movement and axial vibration. The rotor clamping ring 18 has radially projecting fingers 21 which extend between the adjacent projecting ends of the rotor bars 10. Figure 3 shows three of the rotor bars 10A, 10B and 10C.

It will be apparent that the rotor bars with an end ring secured to the ends of the bars at each end thereof may be said to form a sub-assembly or fixed structure. The rotor bars extend through respective openings in the stack of laminations which form the rotor core. There is some clearance between the sides of the rotor bars and the sides of the openings in which they are mounted. Torsional vibration may occur between the sub-assembly and the core, particularly if there is a resonant frequency with air gap torque harmonics such as may occur in variable speed drives.

In the present invention the fingers 21 adjacent the rotor bar 10A have a recess or pocket 22 on either side of the bar 10A, and in the pocket 22 is mounted a respective damper block 23 of resilient material. The damper blocks 23 are compressed to bear against the rotor bar 10A and against the pocket surface in the respective finger 21. This damps any torsional vibration which may occur. It has been found that the use of damper blocks 23 mounted to press against only one rotor bar will damp vibration, but it is preferred to mount damper blocks at two or more spaced rotor bars.

The damper blocks may be easily inserted in each damper block retaining socket before the rotor bars are installed. The material from which the damper blocks are made must be able to withstand the heat

caused by welding the rotor bars to the end rings. It has been found that the damper blocks may be installed subsequent to the welding of the rotor bar ends to the end rings, and this will be explained with reference to Figures 4A and 4B.

Referring to Figure 4A, it will be seen that the recess or retaining pocket 22A is now in the form of an inclined slot. The damper block 23A is inserted in the slot like retaining pocket 22A, which extends to the edge of the rotor clamping ring 18, and pressed inwardly. When the damper block 23A is in position, it engages both the surface of pocket 22A and the adjacent surface of a rotor bar. Frictional forces will tend to retain the damper block 23A in its proper position. Further, when the machine is operating, centrifugal force will tend to press the damper block 23A outwardly, away from the rotor shaft, so that it will remain in its proper position in retaining pocket 22A.

Referring to Figure 4B, the recess or retaining pocket 22B has an "L" shaped configuration with the portion closest to the rotor shaft extending to the edge or surface of the rotor clamping ring 18. The damper block 23B is inserted in the L shaped recess or retaining pocket 22B where it opens at the surface of retaining ring 18, and is pressed inwardly and then radially outwardly. When the damper block 23B is in position, as seen in Figure 4B, it will bear against both the surface of retaining pocket 22B and the surface of the adjacent rotor bar where frictional forces will tend to retain it in position. Also, when the machine is operating, centrifugal force will tend to press the damper block 23B radially outwardly away from the rotor shaft thereby tending to retain it in position.

It is believed that the preceding description clearly describes the invention which will be defined in the following claims.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A damping means for damping torsional vibration in a rotor of a dynamoelectric machine having a rotor core comprising\a stack of laminations, a plurality of circumferentially spaced openings extending axially through the core, a rotor bar in each opening projecting from either end of said core, and an end ring at each end electrically connected to the projecting ends of said rotor bars at a respective end of said core, the rotor bars and the end rings forming a sub-assembly, comprising:

a clamping ring at each end of said stack of laminations to clamp said stack of laminations together, said clamping rings having radially projecting fingers each extending between projecting ends of adjacent ones of said rotor bars and spaced therefrom,

at least one of said fingers having a damper block retaining pocket facing a projecting end of a rotor bar, and

a damper block of resilient material mounted in the respective damper block retaining pocket engaging said pocket and a radially adjacent surface of the adjacent rotor bar to damp torsional vibration between said sub-assembly and said rotor core.

2. A damping means as defined in claim 1 in which the fingers on a first clamping ring at a first end of said core have on both sides of a first rotor bar a damper block retaining pocket therein and a damper block mounted in each respective damper block retaining pocket for engagement with the respective pocket and with a respective side of said first rotor bar.

3. A damping means as defined in claim 2 in which the fingers on a second clamping ring at a second

end of said core opposite said first end have on both sides of said first rotor bar a damper block retaining pocket therein and a damper block mounted in each respective damper block retaining pocket for engagement with the respective pocket and with a respective side of said firs rotor bar at said second end.

4. A damping means as defined in claim 3 in which there is in addition at least a second rotor bar, spaced from said first rotor bar, provided with damper blocks in engagement therewith mounted in pockets in adjacent fingers for reducing torsional vibration between said sub-assembly and said rotor core.

5. In a variable speed drive, a squirrel cage type dynamoelectric machine, a rotor core comprising a stack of steel laminations having axially extending peripheral openings therein, a rotor bar in each opening projecting from either end, a clamping ring at each end of said stack of laminations mounted to a rotor shaft for clamping said stack of laminations together, said clamping rings having fingers which extend between the projecting ends of adjacent rotor bars and spaced from the projecting ends, and an end ring at each end of the rotor electrically connected at a respective end to the projecting ends of the rotor bars, said rotor bars and said end rings forming a sub-assembly,

a recess in a respective finger on either side of a rotor bar facing said rotor bar, and

a damper block of resilient material mounted in each recess compressed to be in engagement with the respective recess and with the facing surface of said rotor bar for reducing torsional vibration between said sub-assembly and said rotor core.

6. A squirrel cage type dynamoelectric machine as defined in claim 5 in which a plurality of spaced rotor bars have damper blocks mounted in recesses in adjacent fingers.

7. A squirrel cage type dynamoelectric machine as defined in claims 5 or 6 in which said recesses are slots in said clamping ring fingers extending to the outward facing surface of the respective finger and inclined inwardly from said outward facing surface and away from said rotor shaft.

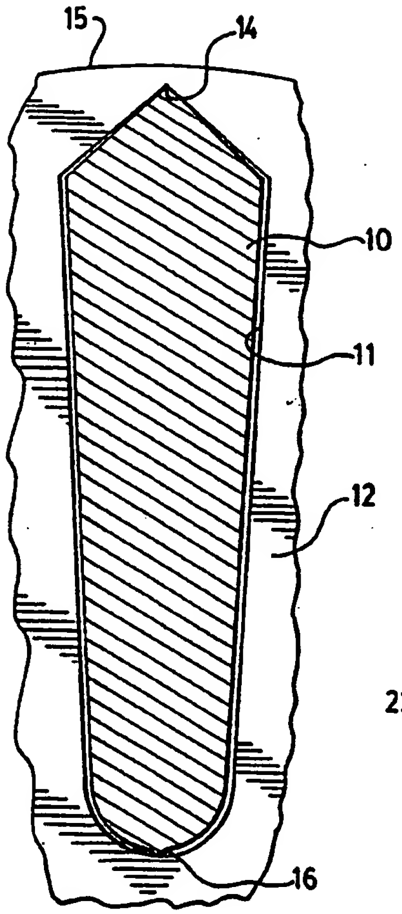
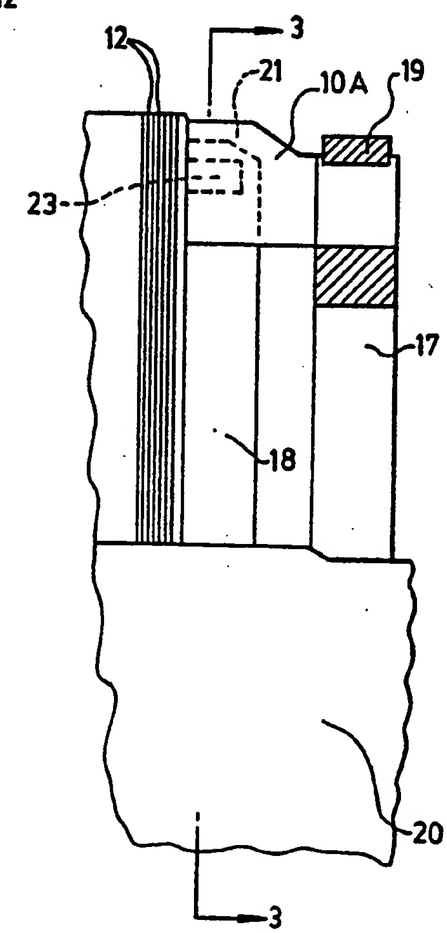



FIG.1.
(PRIOR ART)

FIG.2.



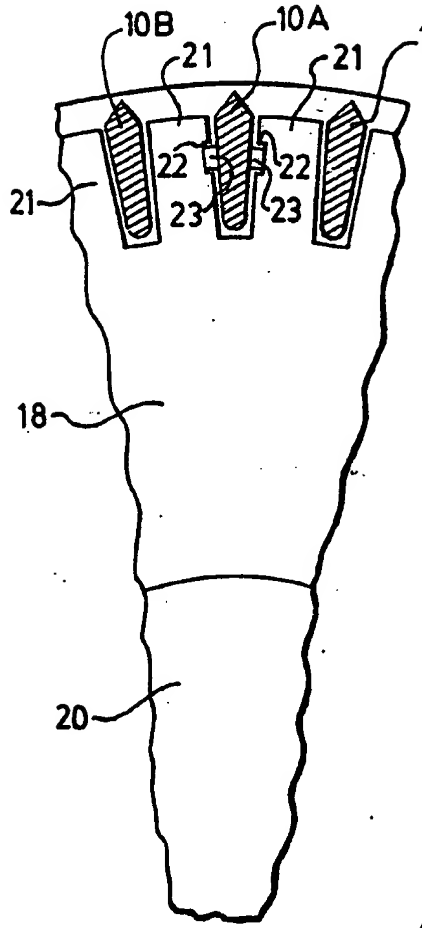



FIG.3.

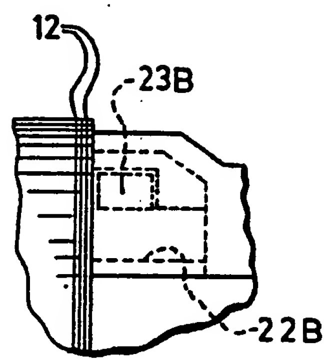



FIG.4B.

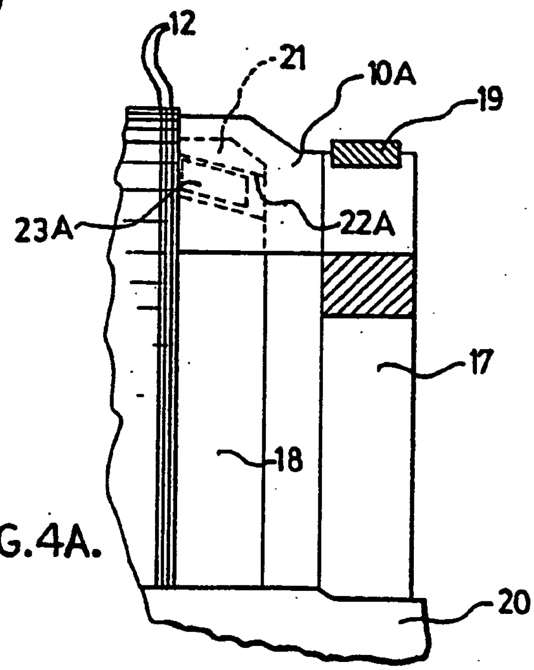



FIG.4A.